

ATTACHMENT E

The Chlorine Dioxide Handbook
Water Disinfection Series

Copyright © 1998 American Water Works Association
All rights reserved
Printed in the United States of America

No part of this publication may be reproduced or transmitted in any form or by any means,
electronic or mechanical, including photocopy, recording, or any information or retrieval system,
except in the form of brief excerpts or quotations for review purposes, without the written
permission of the publisher.

American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235

Editor: Bill Cobban
Copy Editor: Phillip Murray
Production Editor: Alan Livingston
Cover and Book Design: Scott Nakuchi-Hawn

Library of Congress Cataloging-in-Publication Data
Gates, Donald J., 1947-

The chlorine dioxide handbook / Donald J. Gates.
xviii, 186 p. 19×24 cm. -- (Water disinfection series ; v. 2)
Includes bibliographical references and index.
ISBN 0-89867-942-7
1. Water—Purification—Chlorination. 2. Chlorine dioxide.
L. Title. II. Series.
TD464.C38 1997
628.1'662—dc21

97-35100
CIP

ISBN: 0-89867-942-7

BEST AVAILABLE COPY

Con

List of Figures
List of Tables
Acknowledgments
Foreword, xi

Chapter 1
Government
Historical
Health Effects
Advantages

Summary
References

Chapter 2
Basic Principles
General
Stabilizers
Non-Chlorine
Generators
Production
Purification
Chlorination
Yields and
Quality
Degradation
Chlorine
Chlorine
Other
References

ANALYSIS METHODS Analytical Chemistry

BEST AVAILABLE COPY

The titration procedures described in this chapter require that calculations and conversions be made based on the chemistry of the method. For example, the amperometric titration makes use of equivalent weights for calculating concentrations on the basis of mass. The term *equivalent weight* is defined as the number of milligrams per equivalents (mg/eq) and is calculated by dividing the molecular weight of the species being measured by the number of electrons transferred during the reaction. Table 6-2 lists the common oxychlorine species, their molecular weights, and the corresponding equivalent weights used in calculating final concentrations during the amperometric titration.

For example, in amperometric method II (see page 109), ClO_3^- is calculated based on the equivalents of reducing titrant required to react with equivalents of oxidant present at a specific pH. Chlorate ion

Oxidation state	Species	Formula /	Table 6-1 Chlorine oxidation states
+7	Perchlorate ion	ClO_4^-	
+6		-	
+5	Chlorate ion	ClO_3^-	
+4	Chlorine dioxide	ClO_2	
+3	Chlorite ion	ClO_2^-	
	Chlorous acid	HClO_2	
+2		-	
+1	Hypochlorite ion	OCl^-	
	Hypochlorous acid	HOCl	
0	Chlorine	Cl_2	
-1	Chloride ion	Cl^-	

Species	Molecular weight (g/mol)	Electrons transferred	Equivalent weight (mg/eq)	Table 6-2 Equivalent weights for oxychlorine species
$\text{ClO}_2 \rightarrow \text{ClO}_2^-$	67.452	1	67,452	
$\text{ClO}_2 \rightarrow \text{Cl}^-$	67.452	5	13,490	
$\text{Cl}_2 \rightarrow 2 \text{Cl}^-$	70.906	2	35,453	
$\text{ClO}_2^- \rightarrow \text{Cl}^-$	67.452	.4	16,863	
$\text{ClO}_3^- \rightarrow \text{Cl}^-$	83.451	6	13,909	

NOTE: During titration at a specified pH, oxychlorine species are reacted (electrons transferred) to form other species (e.g., Cl^-).